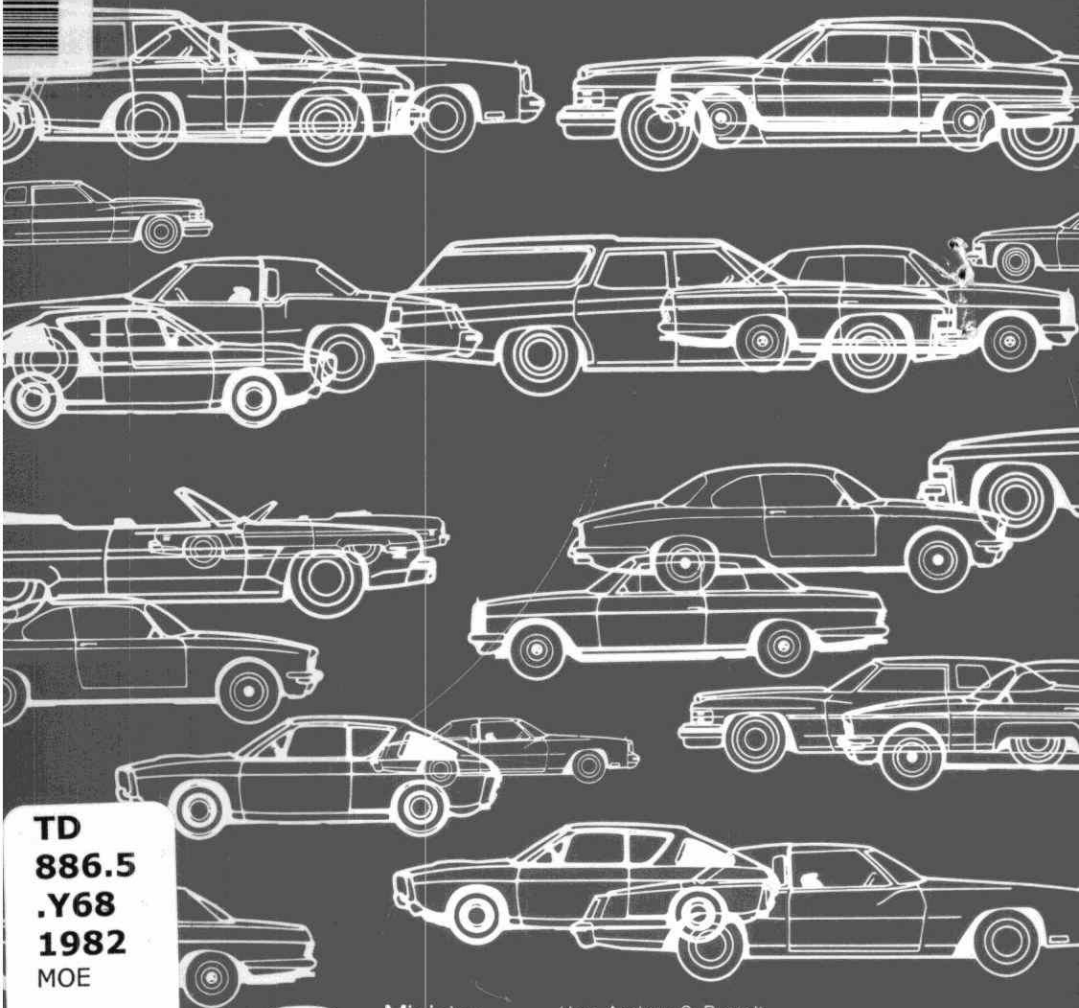


YOUR CAR AND AIR POLLUTION

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Ministry
of the
Environment

Hon. Andrew S. Brandt
Minister

Brock A. Smith
Deputy Minister

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Your car and air pollution : a
comprehensive handbook on
automotive emission regulations
as administered by the Ontario
77219

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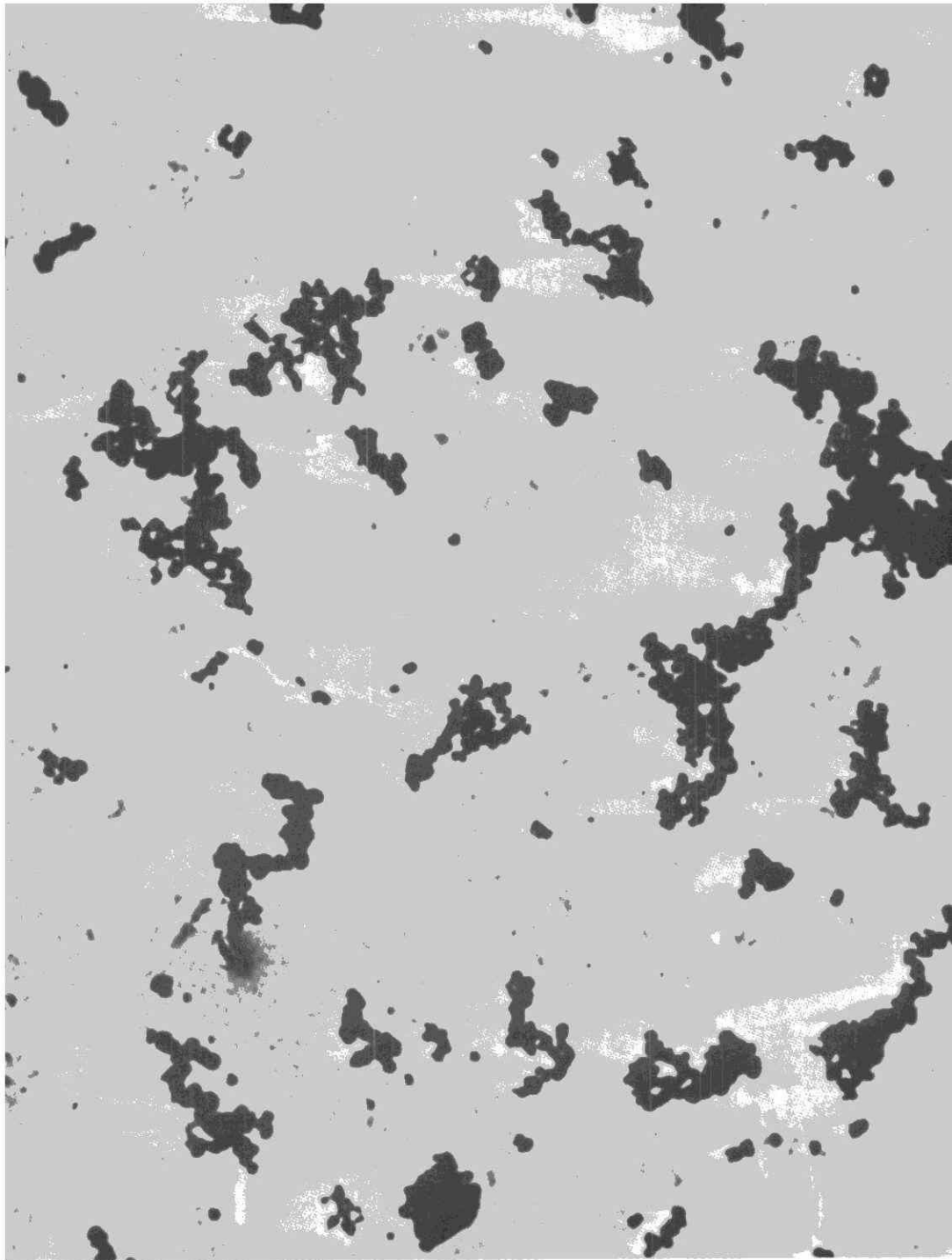
Brock A. Smith
Deputy Minister

Air Resources Branch
Vehicle Emissions Section



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Particulate matter being discharged from an automobile exhaust, magnified several thousand times.

INTRODUCTION

In the brief span of 20 years, the field of environmental protection has grown from the concern of a handful of visionaries to a major responsibility of government agencies around the world.

At the forefront of this tremendous surge of human awareness and the development of modern pollution abatement technology has been the Government of Ontario which established the Ontario Water Resources Commission in 1957, the first agency of its kind in the world.

Ontario was among the first to take further steps in protecting its natural environment by establishing an effective system of air pollution control and other units to deal with environmental issues such as waste management and controls in the use of pesticides. The formation of the Department of the Environment followed in 1970 and all the Province's environmental agencies were amalgamated into the Ministry of the Environment in 1972.

This pioneering commitment to environmental protection has led to research, legislation and policies which have made the Province a recognized leader in the environmental field. To provide Ontario's 8.5 million citizens with effective environmental management the Ministry has set four major goals:

1. To ensure proper control over the emission of contaminants into the natural environment for the purpose of achieving and maintaining predetermined standards of environmental quality.

-
2. To ensure that proposed programmes, projects, policies and legislation in, or affecting, Ontario incorporate the necessary environmental safeguards through direct involvement in the co-ordination and development of a provincial land-use plan.
 3. To foster the improved management of waste and water to achieve a more efficient use of natural and material resources.
 4. Where the above measures are not sufficient, to develop specialized techniques for the restoration and enhancement of environmental quality.

As air pollution increases, certain effects become apparent. Visibility is reduced, vegetation is injured, property and clothing are soiled, and most vital of all, human health is affected.

Reduction in visibility is due to the concentration of aerosols* in the atmosphere. There are two basic effects: a darkening of the sky, and haziness due to scattering of light. Sky darkening is the physical obstruction of sky illumination by clouds containing smoke and fumes. Haziness is the alteration of sky illumination due to light scattering. The blue colour of the sky is the result of sunlight being scattered by molecules of atmospheric gases. Similarly, the colour of the sky can be changed by pollution hazes. The type and degree of change depend upon the size of aerosols present, relative to light wavelength.

*aerosol: a suspension of fine solid or liquid particles in gas (as smoke, fog, or an insecticide).

Visibility reduction is an indication of pollution accumulation. Its measurement is one way in which pollution intensity can be determined. Visibility records can be used to show daily, weekly, monthly, and yearly variations. They reflect not only weather variations, but also changes in industrial practices and in the effects of pollution control procedures.

As the sky is darkened, either by normal cloud or pollution effects, the amount of available sunlight reaching the ground is reduced. Sunlight is essential to human and plant life. Its obstruction due to any cause can be a serious matter if it occurs often or over prolonged periods of time.

Serious pollution episodes have occurred in various parts of the world. In Donora, an industrial community located in a deep valley 48 kilometres south of Pittsburgh, thousands of people became ill, several hundred were hospitalized, and twenty died when air pollutants from mills, smelters, and acid plants accumulated during a calm period of weather in October of 1948 and did not disperse for 4 days. In London, England, a much more serious episode occurred in December 1952. During a period of calm weather, air pollutants became so concentrated that 4000 deaths resulted from various respiratory diseases both during and after the episode.

The effect of day-to-day exposure to lower concentrations of air pollution is very difficult to assess. Some individuals are relatively susceptible, others are less so. On the whole, people who live in industrial centres have an increased

chance of getting certain diseases of the respiratory system.

Some forms of air pollution are more annoying than harmful. This is true of many unpleasant odors. Where the main source of pollution is the automobile, the air may cause the eyes to water and the throat to be irritated without having any apparent lasting effect. Much research is still required to determine the long-term effects of exposure to polluted air.

THE ROLE OF THE ONTARIO MINISTRY OF THE ENVIRONMENT IN CONTROLLING VEHICLE EMISSIONS

The Federal Government establishes all emission standards for new vehicles being sold in Canada, but permits the manufacturers to meet these standards using any control methods that they wish. Provincial governments are responsible for the control of pollution from motor vehicles after they have been sold.

SPOTCHECKS

The Vehicle Emissions Section of the Ministry of the Environment's Air Resources Branch assesses the effectiveness of the exhaust emission controls and ensures compliance with the Environmental Protection Act. Since 1971, this Section has carried out an extensive auto emission inspection programme and conducted spot-checks on vehicles all over the Province. It operates a permanent testing facility on Castlefield Avenue in Toronto and during the summer months inspectors travel the Province in mobile units, testing vehicles in other communities.

If an inspection reveals that any of the factory-installed pollution control devices have been removed, disconnected, or tampered with, or if the levels of carbon monoxide and/or hydrocarbons exceed the mandatory levels, a violation notice could be issued with a time limit for the violation to be rectified. **FAILURE TO COMPLY WILL RESULT IN SUMMARY ACTION.**

It is of interest to note that in some North American communities, inspections similar to our's are mandatory once a year for all vehicles.

DEALER INSPECTIONS

The inspection of vehicles on used-car lots by Ministry inspectors was found to be necessary following many complaints by citizens who purchased used vehicles with pollution controls removed or disconnected. We would like to point out that the majority of dealers are most co-operative and welcome this facet of our programme.

VEHICLE INTERIOR TESTING

It is not uncommon for the public to request that the Vehicle Emissions Section test the interior of a vehicle for the possible presence of carbon monoxide, due possibly to a defective exhaust system.

Inspectors from the Vehicle Emissions Section will first perform a stationary idle and fast idle carbon monoxide and hydrocarbon test and also do a visual inspection of the car. The vehicle is then driven in both stop-and-go city, and highway legal speed conditions, while levels of carbon monoxide as low as ten parts per million are recorded on an extremely sensitive Carbon Monoxide Tester.

When the test has been completed, the inspectors will analyze the results and make suggestions to the owner as to how to eliminate the problem, if a problem actually exists. Experience in this type of testing has shown that many complaints of this type are actually caused by high emissions from other vehicles, which enter the complainant's vehicle through the ventilation ducts or open windows.

COMMUNITY COLLEGE PROGRAM

Licensed Motor Vehicle Mechanics from our staff of inspectors in the Vehicle Emissions Section visit the Community Colleges in the Province during the September to June term. Each term, approximately 3,000 Apprentice Mechanics are shown an audio-visual program which depicts the activities of the Vehicle Emissions Section. A general discussion and question-and-answer session relating to the Environmental Protection Act, along with items of mutual interest about emission control equipment, are also conducted during each visit.

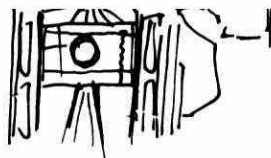
LEGISLATION

The legislation under which the Ministry carries out these functions is the Environmental Protection Act, specifically Sections 20, 21, 22, 127 and 128, and Regulation 311, R.R.O. 1980. These are set out in full at the back of this pamphlet on pages 21 through 27.

IMPORTING A VEHICLE INTO CANADA

Any vehicle being imported into Canada must comply with the safety and emission standards enforced by Transport Canada in the Motor Vehicle Safety Act. Detailed information is available on request.

CONTROL OF VEHICLE EMISSIONS



Vehicle manufacturers install pollution control equipment on their products to comply with various government standards. These control systems reduce the emission of 3 main types of pollutant: hydrocarbons, carbon monoxide and oxides of nitrogen.

HYDROCARBONS

Gasoline, like all petroleum products, is made up of hundreds of hydrocarbon compounds. The name "hydrocarbon" has been given to these compounds because they are made up of hydrogen and carbon atoms. This is also the reason hydrocarbons have the abbreviation (HC).

Hydrocarbons are gasoline vapours or raw gasoline itself. One reason hydrocarbon emissions must be controlled is because they are one of the major components of photochemical smog, which forms when hydrocarbons and oxides of nitrogen react in the presence of sunlight. Hydrocarbons also act as an irritant to our eyes and some are suspected of causing cancer and other health problems.

Formation of Hydrocarbons

Hydrocarbons are emitted from a vehicle's fuel system (fuel tank, carburetor, etc.). They are also emitted from the tailpipe. If the automobile engine could achieve "complete combustion", all of the unburned fuel or hydrocarbons would be used up. However, it is impossible for today's automobile engines to achieve "complete combustion". Any time the fuel mixture in the combustion chamber is not completely burned, some hydrocarbons will be emitted

from the tailpipe. The two main reasons why hydrocarbons are not completely burned are because of engine misfire and "quench areas". When an engine misfires, most of the fuel remains unburned. When this happens it is simply exhausted from the tailpipe. Quench areas are places in the combustion chamber where the flame goes out before the fuel is completely burned. Quench areas are small cavities such as the space where the head gasket seals the cylinder head to the block. Another quench area is located between the top of the piston and the first compression ring.

CARBON MONOXIDE

Another product of combustion that must be controlled is carbon monoxide. Carbon monoxide has the abbreviation (CO). CO is also hazardous to our health when it is mixed with the air we breathe. It can cause headaches, reduce mental alertness and even cause death in an enclosed area. Carbon monoxide is also a problem in that it is an active intermediate in photochemical smog formation.

Formation of Carbon Monoxide

Carbon monoxide is partially burned fuel. Carbon monoxide is formed in the combustion chamber whenever there is not enough air to burn all the fuel. This means that whenever a "rich" air/fuel mixture is induced into the combustion chamber, carbon monoxide will be formed. After the flame goes out, the carbon monoxide is exhausted through the tailpipe and into the air.

OXIDES OF NITROGEN

Oxides of nitrogen are the last harmful products of combustion we will discuss. Nitrogen oxides have been given the abbreviation (NO_x). As you already know, oxides of nitrogen and hydrocarbons combine to form photochemical smog. Side reactions involving NO_x and oxygen also occur with the production of ozone (O_3). Ozone is a lung and eye irritant and it also deteriorates rubber and affects the growth of vegetation.

In Ontario, ozone occurs mainly on warm, humid days between April and October if the following conditions also prevail:

1. Daily maximum temperatures of around 28°C , nightly minimum 16°C .
2. Less than 80 per cent cloudy sky.
3. Calm conditions or southerly winds of less than 32 kilometres per hour.

The conditions for ozone formation and build-up are good near the Great Lakes. Traffic entering a large, densely populated, Metropolitan area, along with industrial production, causes a buildup of ozone during the day. After the land cools in the evening, ozone is moved out to the warmer lake by a "shore breeze" or the predominant wind flow where it lies dormant during the night. Early the next afternoon, the cooler 'lake breeze' travels toward the warmer land carrying a portion of the preceding day's ozone with it. Thus ozone keeps accumulating until a new air mass breaks the cycle.

Formation of Oxides of Nitrogen

Air consists mainly of nitrogen and oxygen. When a fuel/air mixture enters the combustion chamber of an engine,

the nitrogen and oxygen can combine to form oxides of nitrogen. This reaction proceeds at temperatures above 1400°C , and combustion chamber temperatures can exceed 2500°C . Conditions which tend to raise the combustion chamber temperature will also enhance the formation of nitrogen oxides.

TAMPERING WITH EMISSION CONTROL DEVICES

Emission control devices are wrongly thought by many people to be the main cause of reduced fuel economy in late model cars. While some devices used on pre-1975 model cars did initially cause a reduction, manufacturers have now developed control systems which are improving fuel economy. Contributing to a reduction in fuel economy are the "options", such as air conditioning, power steering, as well as reduced engine compression ratios to enable the engines to operate efficiently on lower octane gasolines.

If the emission control devices are disconnected or tampered with, this interferes with the operating balance of the engine—and will decrease the fuel economy. On some vehicles equipped with an air pump, the injected air from the pump aids in cooling the exhaust valves. If the air pump is not operating, this can result in overheating and burn-out of the exhaust valves.

If the Exhaust Gas Recirculation system is blocked or disconnected, this can also cause higher combustion chamber temperatures, resulting in damaged en-

gine components. On some car models equipped with an automatic transmission, an inoperative E.G.R. system can result in a change of vacuum to the control mechanism of the transmission system. This causes gear changes to occur at the wrong engine speed which could damage the transmission and could also put abnormal stress on the engine.

Many other driveability problems can be directly attributed to disconnecting or tampering with emission control equipment.

Manufacturers' procedures and specifications must be rigidly adhered to for maximum performance and fuel economy.

- Improper timing.
- Improper or inadequate maintenance of emission control devices.

Usually a tune-up will correct the pollution problem and also improve your engine's performance and increase fuel economy. We recommend that you take your vehicle to a reliable service facility which has an exhaust emission tester and employs a licenced mechanic.

FAILING AN EMISSIONS TEST

If a vehicle fails an emission test, it could be for one or all of the following reasons:

Visible smoke—generally caused by:

- Improper or inadequate maintenance of the engine.
- Worn piston rings, valves, or valve guides.

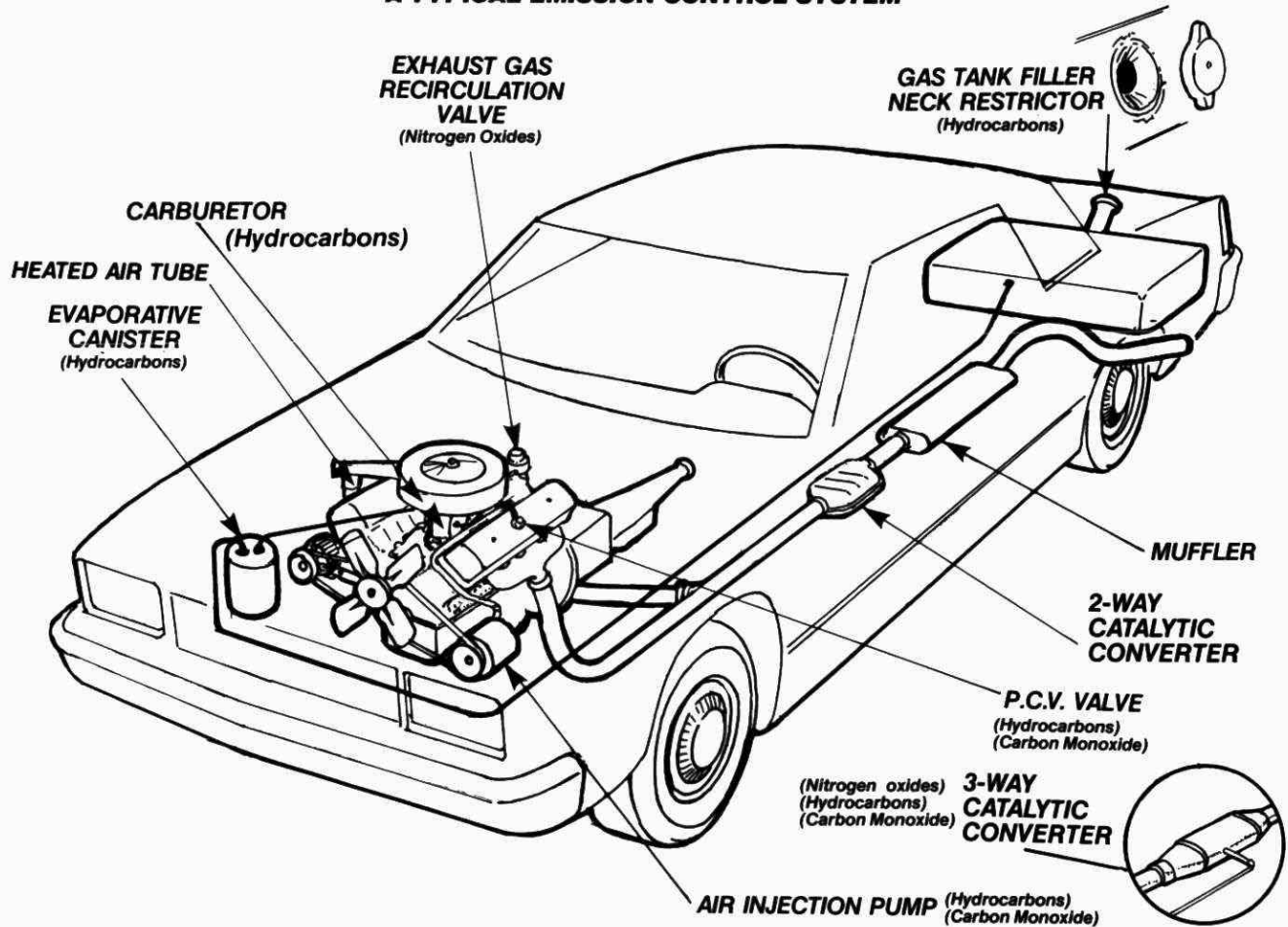
Excessive carbon monoxide emissions—generally caused by:

- Incorrect carburetor adjustment.
- Restrictive or dirty air cleaner.
- Improper or inadequate maintenance of emission control devices.

Excessive hydrocarbon emissions—generally caused by:

- Faulty ignition or engine misfire.

A TYPICAL EMISSION CONTROL SYSTEM



FUEL ECONOMY, PERFORMANCE AND EMISSIONS

MAINTENANCE

Three parameters that are usually considered when evaluating the operation of a vehicle are fuel economy, performance and pollutant emissions. These are inter-related in that any modification aimed at improving one of them usually affects the other two.

Good maintenance is essential, because a poorly tuned engine burns fuel inefficiently, causing reduced fuel economy and increased pollutant emissions.

A car engine requires 7,500 litres of air for every litre of gasoline. A dirty air filter alters this ratio and can reduce fuel economy by up to 10%. In addition, a single misfiring spark plug can reduce fuel economy by up to 10%. Plugs should be cleaned and regapped as part of regular servicing, and changed as needed. Other simple causes of fuel waste: incorrect timing and worn points. The ignition advance mechanism (mechanical and vacuum) should also be checked.

One of the biggest wasters of gasoline is the choke. A slow or stuck choke forces the engine to induce too much gasoline. This can increase gas consumption by up to 30% — and damage the engine.

The best ignition, points and spark plugs are wasted if the proper power isn't being delivered. Electrical circuits and connections should be examined to ensure that the system is delivering maximum voltage with minimum resistance. A low voltage gives a weak spark, causing the engine to take longer to start, and, once running, gives a less

efficient firing of the fuel mixture. Other items that have a minor effect on fuel economy and emissions are the universal joints and wheel bearings which should be kept properly lubricated.

Under-inflated tires increase rolling resistance. This puts an added burden on the engine and uses extra gasoline. Tires should be checked at least once a month, and the pressure kept at the high end of the range recommended in the driver's manual.

Brakes are supposed to brush slightly to keep the drum (or disc) clean and dry. If they are dragging, this can reduce fuel economy seriously, as well as hasten a major brake job. It is difficult for the average driver to spot drag, but a mechanic can find the trouble in less than five minutes.

When an engine is too hot or too cold, it burns extra gasoline. The pressure cap and cooling system should be checked, worn hoses replaced, fan belt adjusted to the manufacturers recommended tension, and the coolant flushed out and replaced if it's contaminated.

The car must be fitted with the thermostat recommended in the manual. The correct operating temperature increases engine efficiency and fuel economy. Another way to prevent overheating is to clean bugs and dirt from the front of the radiator.

An owner's manual will list the correct grade of gasoline for a car. The fuel tank should not be filled right to the very top of the filler neck. Room should be left for expansion, and to avoid loss through the overflow pipe and when cornering. This reduces evaporative

emissions and prevents fuel wastage.

The fuel lines should be checked and tightened to prevent leakage. Excessive fuel pump pressure wastes fuel and can be corrected.

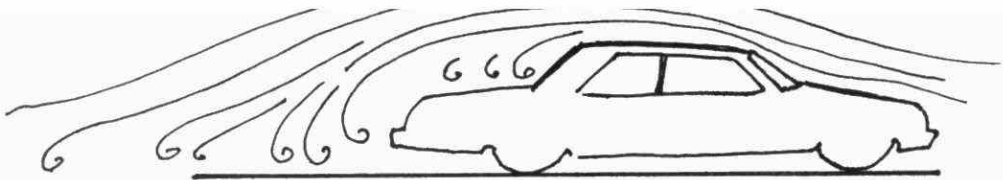
Use of the recommended grade of engine oil is essential. Lubricants that are too thin may cause damage through

excessive wear; those that are too thick require more power and that means more gasoline. The proper grade reduces friction, allows the engine to run easily and results in better fuel economy. It's also a good idea to keep the oil level up to the mark in the transmission and differential.

EFFECT OF DESIGN VARIABLES ON FUEL CONSUMPTION

Variable	Low fuel consumption	Low emissions	Performance/ driveability
ENGINE			
Compression Ratio	High	Low	High
Spark Timing	Optimum	Retarded	Optimum
Air/Fuel Ratio	Lean	Lean	Rich
Size	Small	Small	Large
VEHICLE			
Weight	Light	Light	Light
Size	Small	Small	Medium
Rear Axle Ratio	Low	Moderate	High
Transmission	Manual	Automatic	Automatic

Automobile engine design requires optimization of compromises between design factors influencing fuel consumption, emissions and performance/driveability. As shown, measures which provide low fuel consumption are often at variance with those that provide good performance, driveability or low emissions.



ENGINE POWER AND FUEL ECONOMY

In theory, the automotive engine is very inefficient, since only 20% of the total power of the fuel is actually used to propel the vehicle. However, not all the remaining 80% is wasted. It must be remembered that the engine also provides energy to heat the passenger compartment or operate the air conditioning, and provide electrical power for a number of auxiliary items such as windshield wipers, defroster, power accessories, headlights, etc.

Friction

Theoretically, it requires no power at all to carry automobile drivers and passengers from one point to another on a flat surface. All the work of the engine is dissipated in friction; in the engine itself, in the transmission, the tires, the brakes and the air surrounding the car. At BEST, an engine can convert only 30 per cent to 40 per cent of its fuel energy to actual mechanical work.

Thermal Efficiency

Thermal efficiency is the mechanical output of an engine, expressed as a percentage of the total energy input. That 30 per cent to 40 per cent figure just quoted is the thermal efficiency of an engine at its ultimate best. Actually, most modern engines have only 10 per cent to 30 per cent thermal efficiency. Diesel is first on the list. Stratified charge is next. Conventional gasoline engines come last.

Increasing Thermal Efficiency

The very nature of an internal combustion engine prevents it from ever achiev-

ing a really dramatic increase in thermal efficiency. However ... MECHANICAL FRICTION losses can be drastically reduced, and the automakers are spending many millions of dollars to do it by redesigning, re-engineering, retooling.

Weight Reduction

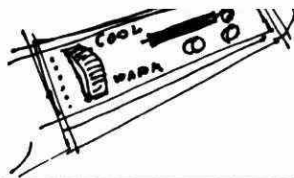
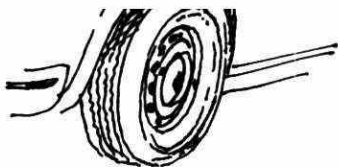
The most visible evidence of the concern for reducing mechanical friction is the switch to smaller cars with smaller engines. Weight reduction has also been achieved through the use of thinner, stronger, lighter materials as well as improved bearings, lubricants, and computer-designed moving parts for better mass-produced precision.

Aerodynamic Drag

Drag is a key factor, in reducing air friction. Air resistance against a moving car increases as the square of the speed. Engine power needed to overcome this drag increases as the cube of the speed! So, twice the speed means four times the drag requiring eight times the engine power to overcome the drag! This explains why fuel consumption increases at higher speeds, and even minor reductions in drag can create significant fuel savings.

Transmissions

With automatics today, low slip torque with lockup clutch is helping to save fuel. At higher speeds in third gear the clutch is locked up and the engine torque is delivered mechanically rather than hydraulically. This cuts slippage loss usual with torque converters. For years manual transmission with overdrive has provided better fuel economy



...but only in the hands of experienced and skillful drivers. In highway driving, manual overdrive can produce a 20 per cent reduction in fuel consumption over automatic. Now, automatic transmissions have been introduced with overdrive to compete with manual transmissions.

Tires

Tires are also a part of the battle. Modern radials allow sidewall flexing without distorting treads. Radials are supposed not to squirm which means they run smoother, cooler and use less energy.

Air Conditioning: Facts and Fallacies

It is often said that the additional weight of air conditioning will increase fuel consumption, whether the air conditioner is in use or not. Although this is true, the weight effect is quite minor, and is offset by the fact that when a car is equipped with air conditioning it sometimes has a far more sophisticated cooling system and fan drive than a similar, non-equipped car. The fact is, some cars with air conditioning turned off use LESS fuel at highway speeds than non-air-conditioned cars due to the more efficient cooling system of the former. Air conditioning can use up to 13 per cent more fuel at certain speeds. **But only in extremely hot weather.** During a normal, long hot summer, the air conditioning penalty will probably not exceed a 5 per cent to 7 per cent increase in fuel consumption. Most important of all is the following fact: **Driving a non-air-conditioned car in summer with the windows open increases aerodynamic drag so drastically that it will burn more**

fuel than the same car with air-conditioning and the windows closed.

Power Equipment

Power steering increases fuel consumption 1 per cent to 3 per cent, but many vehicle owners consider that the benefits are so great it is worth it. Most accessories have little or no effect on fuel consumption. Power brakes and higher output alternators make little difference unless extra loads are imposed.

Acceleration and Braking

Braking is far more wasteful of fuel than acceleration. Acceleration uses metered fuel as and when it is needed. Once vehicle inertia is overcome and the mass is on the move, light throttle is all that is needed to keep a vehicle rolling. But when brakes are applied, **all of the vehicle energy is dissipated.**

Speed

With manual transmission, fuel consumption is best at a constant 45 to 55 km/H. Automatic without lockup does best from 55 to 75 km/H. With lockup, the best fuel efficiency is just above lockup speed. Fuel consumption rises sharply at higher speeds. The average automobile will increase fuel consumption around 7 per cent for every 10 km/H over 80 km/H.

Engine Idling

An hour at curb idle would run the car 15 kilometres at 40 to 70 KM/H on the amount of fuel used idling. During long tie-ups many authorities recommend shutting off the engine. Actually, 15 seconds of idle will use more fuel than you will use restarting the engine.

Electrical Accessories

Electric rear window defrosters increase fuel consumption about two per cent, and headlights and wipers are used only when necessary. Radio and power windows use so little energy they have negligible effect on fuel economy.

Vehicle Loading

Every extra 50 kg of weight added increases fuel consumption about one per cent. Loading also applies to the fuel tank. A car with a full tank uses more fuel than it does with a part-empty tank. As the level of fuel in the tank goes down, a vehicle's fuel economy increases slightly.

Fuel Economy in Wintertime

Cold weather warm-up uses a lot more fuel than warm-up in temperate weather, obviously. In winter, lubricants have higher viscosity and more energy is used to churn and shear them. Also in wintertime, colder air is DENSER air which means even more aerodynamic drag. Warm-up at fast idle with choke on can triple fuel consumption. The best fuel economy is obtained by eliminating the warm-up idling period, and just driving away with moderate acceleration and speed. In severe winter weather a block heater is excellent. But it should not be plugged in and left on all

night because the saving in fuel will be offset by the extra electricity used for the heater. Use a timer to switch on the heater about two hours before the car is due to be driven away.

DIESEL

DIESEL SMOKE CONTROL

Heavy duty vehicle smoke control is achieved by enforcement of the provisions of section 57 of the Highway Traffic Act. A diesel inspector rides on patrol with an O.P.P. officer, and when he observes trucks and diesel powered vehicles that he considers are emitting excessive levels of smoke, he informs the police officer who stops the vehicle and charges the driver. The main contaminants of diesel exhaust are hydrocarbons, oxides of nitrogen, particulates, and small percentages of carbon monoxide, oxides of sulphur, and organic acids.

EMISSIONS FROM GASOLINE & DIESEL POWERED ENGINES

The diagram shown opposite gives a general comparison of the various pollutants produced by gasoline and diesel powered engines. The diesel emits less carbon monoxide (CO) and hydrocarbons (HC) than the gasoline engine. The nitrogen oxides (NO_x) emitted are about the same for the two types of engines. Smoke and odor emissions, however,

are much greater from the diesel than from the gasoline engine. Some diesels may produce smoke when operated with an air-fuel ratio less than 25:1. Odor production from diesels, however, does not seem to be directly related to the air-fuel ratio.

TYPES AND CAUSES OF SMOKE

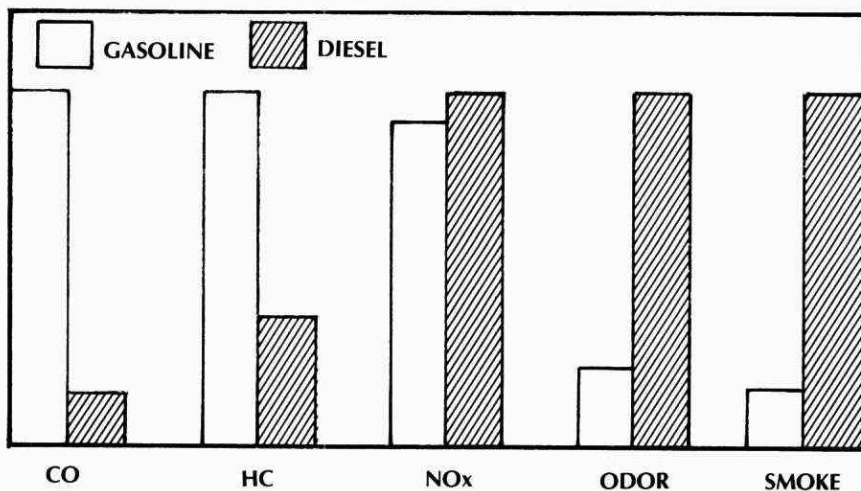
Smoke is usually the result of incomplete combustion. The types of smoke and their composition are:

1. **Black, or dark brown smoke**, which consists of unburned carbon particles (soot) and is usually associated with operating speeds, loads, and fuel system problems, e.g. pumps, fuel and transfer, faulty injection systems, injectors and filters.

2. **Blue smoke**, which contains unburned engine oil that reaches the combustion chamber because of worn piston rings, cylinder liners, and/or valve guides. Some partially burned fuel may also be present in this type of smoke.

3. **White smoke**, which is made up of droplets of unburned liquid fuel and is usually associated with the startup or idle of some engines at cold temperatures.

Black smoke, the most common type of exhaust smoke, is the main concern of our inspectors. Black smoke is always the result of incomplete combustion. White smoke can be reduced by reducing idle time, especially after initial

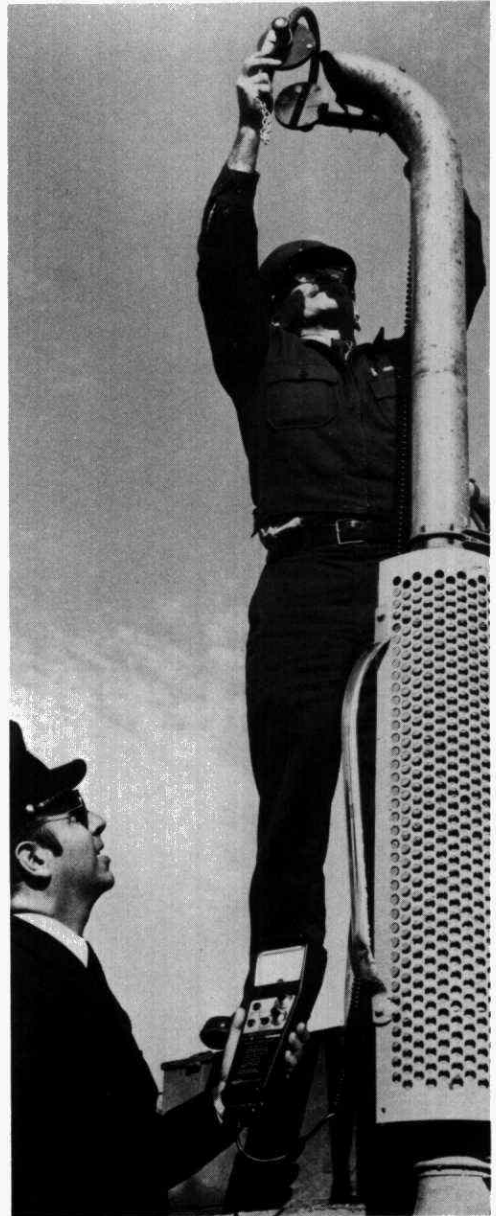


Relative levels of pollutants emitted by gasoline and diesel-powered vehicles

startup, and by using fuel that has the right ignition properties for the climate or prevailing temperature. White smoke can also be reduced by parking the vehicle indoors or by using engine-block heaters. Blue smoke can usually be eliminated by engine maintenance or overhaul.

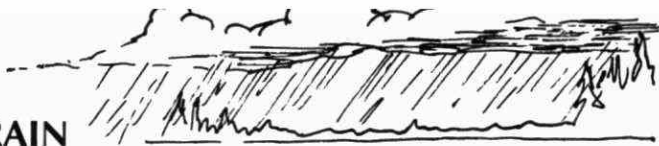
TYPES AND CAUSES OF ODOR

The chemical compounds in the exhaust that cause odor have not yet been identified. Diesel odors are even harder to describe. In fact, observers have to be trained for the job of judging kinds and amounts of odors because no instruments now available can measure odor. Just as the methods of judging and describing odors are far from satisfactory, the exact cause of odors is not well know.



Ministry inspectors check diesel stack.

IMPACT OF ACID RAIN



The phenomenon of acidic precipitation, commonly known as acid rain, is acknowledged by scientists and governments to be one of the most pressing environmental issues facing widespread areas of eastern North America, western Europe and Scandinavia.

Research attributes most of the acid rain in eastern North America, and elsewhere, to pollution from sulphuric and nitric acid. These acids are formed by a complex series of chemical and physical processes. The chemistry is only partially understood at present, but essentially the problem begins when sulphur and nitrogen compounds are emitted into the atmosphere as a result of man's industrial activities *and his use of modern transportation vehicles.*

The sulphur and nitrogen emissions originate chiefly from the combustion of fossil fuels, such as coal and oil, from power generating plants, ore smelting, *petroleum refining*, industrial furnaces *and from vehicles of all kinds.*

Acid rain evolves through a cycle of four consecutive stages — sulphur and nitrogen emissions, long range atmospheric transport, transformation of chemical properties, and, finally, fallout of these pollutants to earth through either precipitation or dry deposition.

Sulphur and nitrogen compounds, emitted primarily in the form of sulphur dioxide (SO_2) and oxides of nitrogen (NO_x), are transported by winds and air currents at high and low altitudes. Meteorological conditions can carry these pollutants hundreds to thousands of miles from their point of emission, allowing time for chemical transforma-

tion to acids. They return to earth eventually in the form of "wet deposition" (acidified rain or snow) — or as "dry deposition" (particulate matter or gases) — on soil, forests, vegetation and water.

With the exception of power generation and industrial combustion, **the major sources of nitrogen oxides are related to transportation vehicles and are therefore more difficult to control, except through internal combustion engine design and regulatory mechanisms.**

This fallout of destructive acid rain, acidic snow, or in lesser degree dry particulate matter, results from long-range transport of air pollutants affecting many regions of the world. Frequently, the areas which produce pollution are unaffected by it, either because its fallout is far away, or the local lakes and soils are well buffered with alkaline bedrock or chemistry.

Scientists know acidic precipitation is having severe ecological effects on the natural environment, particularly lakes, rivers and fisheries, man-made structures and buildings, and fear long-range effects on forests and other vegetation.

WORLDWIDE IMPACT AND CONCERN

The chief and immediate concern about acid rain is that it ultimately affects aquatic life in lakes and watersheds which have quartzite or granite-based geology, rather than limestone bedrock. These lakes and rivers are sensitive to acidity because they have very little "buffering"*** or neutralizing capability.

This condition is evident in many of the lakes in Canada's Precambrian

Shield, including the Muskoka and Haliburton lakes, and many others in northern resort regions, where little natural limestone exists.

Since the mid-1950's, hundreds of such lakes in eastern North America, Scandinavia and parts of Western Europe which have little buffering ability have become so acidic they can no longer support fish and aquatic life. Ontario Government scientists have documented that there are some 140 lakes in the Province, mostly centred around Sudbury, which are fishless because highly acidic conditions have inhibited reproduction. Well over 200 lakes in the Adirondack mountains of New York State, and hundreds in southern Norway and Sweden have been found to be suffering from a similar plight.

In addition, it has been found that many well-buffered lakes can lose an entire year's hatch of valuable sports fish due to the acidic shock effects of spring run-off, when the pollutant-laden winter accumulation of snow suddenly melts into waterways.

While many of the aquatic effects of acid rain have been documented, data related to other possible impacts are just beginning to be compiled. There is considerable evidence to support the premise that if the current trend to increased acidity continues, the growth

***"BUFFERING" is the ability to neutralize or stabilize free hydrogen ion input, or acidity, and is usually present in regions where limestone or alkaline soil chemistry is prevalent.



of forests and crops may be stunted or adversely influenced.

CONCERN AND EFFECTS IN ONTARIO

While the acidic condition of Scandinavian lakes and those of the Adirondack mountains have been known for several decades, the scope of the vulnerability of Canadian lakes far removed from industrial activity was recognized much more recently.

Scientists estimate that, if 1980 levels of acid loadings remain constant or increase over the next 10 to 20 years, Ontario could lose much or all of the aquatic life in as many as 48,000 susceptible lakes unless effective abatement measures are taken. A major programme is well underway in Ontario to identify the current state of susceptible lakes.

Thousands of lakes in Quebec, and the Atlantic Provinces are also susceptible, and many are already afflicted or threatened since they lie in the path of acid emissions from the interior of the continent.

The severity of the situation in Ontario, and the need for quick abatement action, results from the increase in acidity of precipitation over the past several decades. Acid rain has increased to the point where the average pH of rainfall for that part of Ontario lying south of the 50th parallel (roughly in line with the "continental divide") is less than 5.0. Many regions of the Province regularly receive rain of pH 4.0 to 4.5.

ACID RAIN—THE pH PARAMETER

Scientists gauge the acidity or alkalinity of a solution by a parameter called the pH, which is a logarithmic measure of the hydrogen ion concentration on a scale ranging from 0 to 14. On the pH scale, a chemically neutral solution has a value of 7, which is midway on the scale. The greater the acidity, the lower the pH value. A change of one pH unit downward implies a tenfold change in the hydrogen ion concentration, or a tenfold increase in acidity: a change of two is a hundredfold. If for example, a pH is 4, it is 10 times more acidic than a pH of 5; a pH of 3 is a hundredfold more acidic than a pH of 5.

Due to the carbon dioxide naturally present in the atmosphere, the pH of normal or "clean rain" in eastern North America is about 5.6.

In areas of southern Ontario, such as the Muskoka and the Kawartha Lakes, the pH of the rain is often found to be 4.5 to 4.0 range, meaning that the rain is many times as acidic as that of "clean rain". Aquatic life in susceptible lakes is considered to be vulnerable when the pH level of the lake lies in the range of 5.5 to 5.0.

There is widespread concern that if these acidic concentrations are sustained over long periods, serious detrimental effects will be experienced by aquatic and terrestrial ecosystems and these acidic effects will remain for years, or, possibly become irreversible.

Fundamental Chemistry

Not all the acid in rain comes from pollution; "clean" or "normal" rain is slightly acidic due to adsorption of small

amounts of natural atmospheric carbon dioxide which, when dissolved in water, forms a weak acid, carbonic acid, similar to that found in soda water or carbonated soft drinks. Rain is also affected by natural sources of air pollution such as forest fires and volcanos.

However, "acid rain" in northeastern North America is frequently many times more acidic than normal rain because of sulphur and nitrogen emissions from man's activities.

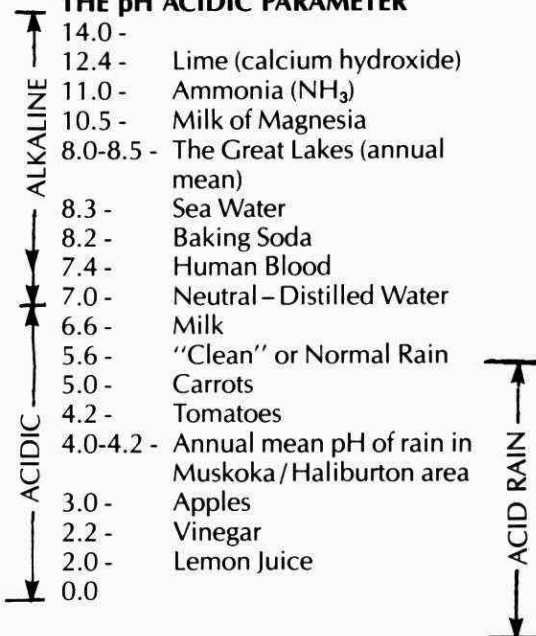
Sulphates are believed to cause about two-thirds of the acidity in precipitation and nitrates responsible for about one-third, throughout most of Ontario.

The rate of conversion reaction of oxides into acids, and exactly how acids are formed in the atmosphere during long-range transport, is still an area of intensive research. There are several complicated pathways or mechanisms by which oxidation can occur. Which path is taken is dependent upon numerous factors such as the concentration of heavy metals in airborne particulate matter, the intensity of sunlight, humidity and the amount of ammonia present. For example, airborne particulate metals such as manganese and iron catalyze or speed-up the conversion of sulphur dioxide to its oxidation products, sulphuric acid and sulphates.

The process by which acids are deposited through rain or snow is called "wet deposition". Another atmospheric process, known as "dry deposition" is the process by which particles such as fly ash, or gases such as sulphur dioxide or nitric oxide are deposited, or adsorbed onto surfaces. While these particles or gases are not always in an acidic

state prior to deposition, it is known that they can be converted into acids after contacting water in the form of rain, dew, or fog following deposition. The precise mechanisms by which dry deposition takes place, and its effect on soils, forests, crops and buildings, are not adequately understood. Much research is being undertaken to clarify the overall acid deposition problem.

THE pH ACIDIC PARAMETER



Regulations Made Under The Environmental Protection Act,

MOTOR VEHICLES

1. In this Regulation,

- (a) "catalytic converter" means a device through which exhaust from a motor is passed in order to prevent or lessen the emission of a contaminant and which device would be impaired in its functioning by the use of leaded gasoline as a fuel for operation of the motor;
- (b) "gross vehicle weight" means the manufacturer's gross weight rating;
- (c) "leaded gasoline" means gasoline that is not unleaded gasoline;
- (d) "light duty motor vehicle" means a motor vehicle having a gross vehicle weight of 2,720 kilograms or less, but does not include a motorcycle;
- (e) "model year", when used with respect to a motor vehicle, means the model year designated by the manufacturer but, where the manufacturer does not make such a designation, means the calendar year in which the manufacture of a motor vehicle is completed;
- (f) "motorcycle" means a motor vehicle having a seat or saddle for the use of the driver and designed to travel on not more than three wheels in contact with the ground and includes a bicycle with a motor attached and a motor scooter;
- (g) "unleaded gasoline" means gasoline that contains not more than 0.013 grams of lead per litre and not more than 0.0013 grams of phosphorus per litre. 311 RRO 1980.

311 RRO 1980

2. Motor vehicles for which a permit under *The Highway Traffic Act* has not been issued are exempt from all the provisions of this Regulation except section 4. 311 RRO 1980.

3.—(1) No person shall use leaded gasoline as a fuel to operate a motor vehicle manufactured with a catalytic converter.

(2) No person shall operate or cause or permit the operation of a motor vehicle with a catalytic converter after leaded gasoline has been used as a fuel in the motor vehicle until the catalytic converter has been repaired or replaced.

(3) A motor vehicle manufactured with a catalytic converter incorporated as part of a system to prevent or lessen the emission of any contaminant shall include, as part of the system, a gasoline tank filler inlet that,

- (a) allows the insertion of a nozzle spout terminal end that has an outside diameter not greater than 2.134 centimetres;
- (b) has a restriction preventing the insertion of a nozzle spout terminal end that has an outside diameter greater than 2.362 centimetres; and
- (c) is designed to pass not more than 700 millilitres of gasoline into the tank when introduction of gasoline is attempted from a nozzle referred to in clause b. 311 RRO 1980.

4. No person shall operate a light duty motor vehicle from which there is a visible emission of a contaminant or contaminants for more than fifteen seconds in any five-minute period. 311 RRO 1980.

5. In respect of a motor or motor vehicle manufactured with a system or device to prevent or lessen the emission of any contaminant, the system or device, or any replacement thereof,

- (a) shall be maintained and kept in such a state of repair that it is capable of performing the function for which it was intended; and

(b) shall be kept installed on, attached to or incorporated in the motor or motor vehicle in such a manner that, when the motor or motor vehicle is operating, the system or device functions in the manner in which it was intended to function. 311 RRO 1980.

6.—(1) For a light duty motor vehicle of a model year and displacement listed in Column 1 of the Table, the figures appearing opposite in the remaining columns are prescribed as maximum emission standards for the vehicle with respect to the contaminant named at the head of each column when tested under the test conditions specified.

(2) Where a light duty motor vehicle is tested for compliance with the maximum emission standards prescribed by subsection 1,

(a) the motor shall be at its normal operating temperature;

(b) the transmission of the motor vehicle shall be in the neutral position;

(c) for the test conditions indicated in Column 2, 4 or 6 of the Table the accelerator pedal shall not be depressed;

(d) for the test conditions indicated in Column 3, 5 or 7 of the Table the accelerator pedal shall be depressed, so as to produce a rotational speed of the motor of between 2,450 and 2,550 revolutions per minute; and

(e) the test, except a test of visible emissions, shall be carried out using an infrared analyzer or other analytical device or procedure of equivalent accuracy.

(3) Every motor vehicle for which emission standards are prescribed in subsection 1 shall comply with such standards.

Table
MAXIMUM EMISSION STANDARDS

311 RRO 1980

		Exhaust Emissions				Visible Emissions of a Contaminant or Contaminants (seconds in any one-minute period)	
		Hydrocarbons (parts per million by volume)	Carbon Monoxide (per cent by volume)				
		Test Conditions					
		idle	fast idle	idle	fast idle	idle	fast idle
1		2	3	4	5	6	7
Model Year	Displacement						
Before 1969	2.29 litres or less	800	800	6	5	5	5
Before 1969	more than 2.29 litres	600	600	5	3	5	5
1969	2.29 litres or less	600	600	5	3	5	5
1969	more than 2.29 litres	500	500	4	2	5	5
1970 or 1971	2.29 litres or less	500	500	4	2.5	5	5
1970 or 1971	more than 2.29 litres	400	400	3	1.5	5	5
1972, 1973, 1974	2.29 litres or less	500	500	3.5	2	5	5
1972, 1973, 1974	more than 2.29 litres	400	400	2.5	1	5	5
1975 or after	2.29 litres or less	400	400	2.5	1.5	5	5
1975 or after	more than 2.29 litres	300	300	2	1	5	5

311 RRO 1980

7.—(1) A provincial officer, designated for the purpose of carrying out the provisions of Part III of the Act, or a police officer may, by written notice in Form 1, require the driver or owner of a motor vehicle to submit such motor vehicle for testing and inspection.

(2) Every driver or owner of a motor vehicle shall comply with a written notice given to him under subsection 1. 311 RRO 1980.

311 RRO 1980

Form 1

The Environmental Protection Act

NOTICE TO SUBMIT MOTOR VEHICLE

TAKE NOTICE that pursuant to *The Environmental Protection Act*, and Regulations thereunder,

Name:

Address:

Driver Licence Number:

is required to submit the motor vehicle bearing Ontario Registration Plate Number (year)

to the inspection site at

on between the hours of
(month) (day) (year)

..... and for testing and inspection.

Dated at this day of, 19....

.....
Provincial Officer
or
Police Officer

(2979)

311 RRO 1980

PART III — The Environmental Protection Act, 1971
MOTORS AND MOTOR VEHICLES

Interpretation	<p>20.—In this part,</p> <p>(a) “motor means an internal combustion engine;</p> <p>(b) “motor vehicle” means a vehicle that uses or incorporates a motor as a source of power.</p>
Sale of motor vehicle that does not comply with regulations	<p>21.—(1) No person shall sell, offer or expose for sale, a motor or motor vehicle that does not comply with the regulations.</p>
Where system or device installed on motor vehicle	<p>(2) Where a manufacturer installs on, attaches to or incorporates in any motor or motor vehicle, a system or device to prevent or lessen the emission of any contaminant, no person shall sell, offer or expose for sale, such motor or motor vehicle unless the motor or motor vehicle has such system or device so installed, attached or incorporated and such system or device, when the motor or motor vehicle is operating, complies with the regulations.</p>
Repair or replacement of system or device	<p>(3) Where a manufacturer installs on, attaches to or incorporates in any motor or motor vehicle, a system or device to prevent or lessen the emission of any contaminant, no person shall remove or cause or permit the removal of such system or device from such motor or motor vehicle, except for repair of such system or device or for replacement of such system or device by a system or device of the same type.</p>
Operation of motor or motor vehicle	<p>22.—(1) Except where necessary for test or repair purposes, no person shall operate or cause or permit the operation of a motor or motor vehicle or any class or type thereof that does not comply with the regulations.</p>
Where system or device required	<p>(2) Where a manufacturer installs on, attaches to or incorporates in any motor or motor vehicle a system or device to prevent or lessen the emission of any contaminant, the owner of such motor or motor vehicle shall not operate or cause or permit the operation of such motor or motor vehicle nor shall any person knowingly operate or cause or permit its operation unless such motor or motor</p>

vehicle has installed on, attached to or incorporated in it such system or device, and such system or device operates in accordance with the regulations when the motor or motor vehicle is in operation.

Powers of
provincial
officer

127.—(1) For the purpose of the administration of this Act and the regulations, a provincial officer may, from time to time and upon production of his designation, enter at any reasonable time any building, structure, machine, vehicle, land, water or air and make or require to be made such surveys, examinations, investigations, tests and inquiries, including examinations of books, records and documents, as he considers necessary, and may make, take and remove or may require to be made, taken or removed samples, copies or extracts.

Order
authorizing

(2) Where a provincial judge is satisfied, upon an *ex parte* application by a provincial officer, that there is reasonable ground for believing that it is necessary to enter any building, structure, machine, vehicle, land, water or air for the administration of this Act or the regulations, the provincial judge may issue an order authorizing a provincial officer to enter therein or thereon and to make or require to be made such surveys, examinations, investigations, tests and inquiries and to take the other actions mentioned in subsection 1 but every such entry, survey, examination, investigation, test, inquiry and other such action shall be made or taken between sunrise and sunset unless the provincial judge authorizes the provincial officer, by the order, to so act at another time.

Information

(3) Every person responsible for a source of contaminant shall furnish such information as a provincial officer requires for the purposes of this Act or the regulations.

Calling for
assistance of
member of
police force

128.—(1) Whenever a provincial officer is required or empowered by this Act or the regulations to do or direct the doing of anything, such provincial officer may take such steps and employ such assistance as is necessary to accomplish what is required, and may, when obstructed in so doing, call for the assistance of any member of the Ontario Provincial Police Force or the police force in the area where the assistance is required and it is the duty of every member of a police force to render such assistance.

Inspection
of motor
vehicles

(2) A provincial officer, for the purpose of carrying out the provisions of this Act and the regulations, may require the driver of any motor vehicle to stop and may inspect the motor vehicle and require the driver of the motor vehicle to submit the motor vehicle, together with its equipment and any trailer attached thereto, to such examinations and tests at such place or places and time or times as the provincial officer considers expedient and where the provincial officer considers it necessary or expedient he may call for the assistance of any member of the Ontario Provincial Police Force or the police force in the area where the assistance is required and it is the duty of every member of a police force to render such assistance.

Duty of
driver
of motor
vehicle

(3) Every driver of a motor vehicle shall stop or submit the motor vehicle, together with its equipment and any trailer attached, to such examinations and tests as may be required by a provincial officer or a member of a police force referred to in subsection 2.

Offence

102.—(1) Except as otherwise provided in this Act, every person, whether as principal or agent, or an employee of either of them, who contravenes any provision of this Act or the regulations or fails to comply with an order or any term or condition of a certificate of approval or a licence made or issued under this Act is guilty of an offence and on summary conviction is liable on a first conviction to a fine of not more than \$5,000 and on each subsequent conviction to a fine of not more than \$10,000 for every day or part thereof upon which such offence occurs or continues.

OFFICE CONSOLIDATION

THIS EDITION IS PREPARED FOR PURPOSES OF CONVENIENCE ONLY,
AND FOR ACCURATE REFERENCE RECOURSE SHOULD BE HAD TO THE
OFFICIAL VOLUMES.

NOTES

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

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Your car and air pollution : a
comprehensive handbook on
automotive emission regulations
as administered by the Ontario

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